ances are sadly wanting in every institution. The full support by the public both legally and morally, with trained men to study and apply the means for treatment, are also wanting. Until such a time, when institutions are founded and conducted by experts, with every resource at command, similar to insane asylums, the difficulties of this work will be very formidable. The results of treatment to-day, with the worst cases, and the crudest means and methods of restoration only faintly indicate the possibility of cure in the future. The restoration of seven in thirty-one cases, after a period of four years and more, is an unmistakable sign of the eminent curability of inebriety, with better means, and larger knowledge.

In a general review of the facts gleaned from a study of these cases, and the results of treatment as seen at this time, I have great confidence in believing that the following propositions are correct, and will be confirmed in all future studies :—

1. Inebriety is a disease, which may be studied, traced, and understood, and whose course or march follows a progressive line, full of hints pointing out the means of cure and prevention.

2. Inebriety is curable as other diseases are, by the application of physical remedies in proper surroundings, by competent men, who seek to apply exact means to meet every case.

3. Inebriety must be studied from a physical point of view, as the result of physiological and psychical laws, and not a matter of chance, or a low vicious element in human nature.

4. Standing on the frontier lines, vast outlines of hills and valleys stretch out before us, all under the domain of law. When the traditional superstition, which hangs over this field, vanishes, and the causes of inebriety are known, as well as the means for prevention and cure, a new era of humanity and civilization will begin.

5. The increasing prevalence of inebriety in this country demands a scientific study of the subject, and a more thorough acquaintance with the laws and forces which govern its rise and progress ; from this a knowledge of the best means of treatment will be ascertained and applied.

ARTICLE V.

INDUCED SEPTICÆMIA IN THE RABBIT. By GEO. M. STERNBERG, M.D., Surgeon U. S. A.

THE object of the present paper is to compare the results obtained in some recently reported experiments upon rabbits (Report to the Scientific Grants Committee of the British Medical Association, by Peter Murray Braidwood, M.D., F.R.M.S., and Francis Vacher, F.R.C.S.Ed., *British*

Med. Journal, Nos. 1100 and 1101, 1882), with the writer's experiments made last year under the auspicies of the National Board of Health. (A fatal form of septicæmia in the rabbit produced by the subcutaneous injection of human saliva. *National Board of Health Bulletin*, April 30, 1881.)

These two series of experiments considered together give confirmation to the view, already entertained by high authorities upon clinical and experimental evidence, that there are two forms of septicæmia; the one a septic toxæmia due to the effects of a chemical poison or poisons evolved during the putrefactive decomposition of certain organic substances—especially of nitrogenous animal products—the other an infectious disease produced by the rapid multiplication in the body of the infected animal of a parasitic organism.

Of the latter form there may be as many varieties as there are species —or physiological varieties (Pasteur)—of bacteria which find in the fluids or tissues of living animals conditions suitable for development. The best studied and most widely known form of septicæmia due to the presence of a parasitic organism is the disease known as anthrax—*charbon* of the French, *miltzbrand* of the Germans—but several other varieties are now well established, in which similar symptoms and pathological results are produced by organisms morphologically different from the *Bacillus anthracis*. Among these may be mentioned the form of septicæmia in the mouse, so well studied by Koch, which is due to a minute bacillus, and the form of septicæmia in the rabbit produced by the subcutaneous injection of human saliva, due to a micrococcus, which has been studied by Pasteur, Vulpian, and by myself (independently). It may be that in both forms of septicæmia, viz., in septic toxæmia from the absorption of certain of the products of putrefaction, and in the infectious septicæmia due to the presence of a parasitic organism, the immediate and essential cause of the disease processes and results is the same, and that the organisms are simply the remote cause as producers of the poison, this being effected in the one case external to the body by an organism which does not find conditions favourable to its development in the interior of the animal, and in the other by one which is able to thrive within and at the expense of the fluids or soft structures of the living body. There is good reason to believe that organisms of the first class which habitually feed upon dead organic material, and require the presence of free oxygen may become habituated to changed conditions and acquire the power of invading living tissues, especially when these are enfeebled as the result of septic toxæmia, profuse loss of blood, wasting discharges, etc. But this is a branch of the subject upon which I shall not enter at present.

Whatever may be the *modus operandi* of the septic poison, or of septic organisms capable of reproduction within the bodies of living animals, there can be no doubt that all varieties of septicæmia are due directly or remotely to the action of bacteria, for it is now well proven that putrefactive processes depend upon the presence, and vital activity of these minute vegetables.

The present state of science justifies us in formulating the axiom *no bacteria, no putrefaction*, and as animal and vegetable tissues subject to putrefaction exert no injurious effect—except in the case of poisonous chemical products evolved in the growth of certain plants—but, on the other hand, are essential for the sustenance of living animals, it is evident that in the end bacteria are responsible for all septic disease processes.

Observation and experiment indicate that septic toxæmia may be acute or chronic, according as it is produced by a single large dose or by frequently repeated small doses of the poison or poisons evolved during the putrefactive fermentation of organic substances; that death may result in a comparatively brief time from a lethal dose of the toxic agent; or, that it may occur at a later date as the result of secondary changes in the blood and in vital organs ; and that the poisoning may occur through various channels, *e. g.*, (*a*) through the lungs by continued respiration of an atmosphere contaminated with emanations from putrefying material—filth ; (*b*) through the mucous membrane of the alimentary canal when putrid matter is taken with food or drink, and probably also from the putrefaction *in situ* of imperfectly digested or unduly retained material in the *primæ viæ ;* and (*c*) from the surface of suppurating wounds, from putrid purulent collections in any part of the body, and from decomposing secretions or discharges from any surface or cavity.

The experiments recorded by Braidwood and Vacher, *l. c.*, were mainly made with lochial fluid undergoing putrefaction, and their results indicate that they produced in the animals experimented upon septic toxæmia of greater or less severity.

The following *résumé* of results is given by the authors themselves.

Résumé.—SERIES A : Infected thirteen rabbits with a solution of lochia itself, or mixed with antiseptics.

Infected four rabbits and one dog with purulent fluid diluted.

Infected four rabbits with an aqueous solution of macerated muscle.

Infected two rabbits and one dog with grumous fluid from the peritoneal cavity.

Of these in seven instances (rabbits), and in two (dogs) recovery took place.

In eleven experiments, the animal (rabbit) was inoculated by injection through the vaginal wall.

In ten experiments the animals (eight rabbits and two dogs) were inoculated subcutaneously.

In three experiments the animals were inoculated by injection through the abdominal peritoneal cavity.

In four experiments the animal (rabbit) received the septic fluid applied to an open wound.

In one experiment the animal (rabbit) was inoculated by injection into a vein.

SERIES B : Infected fourteen rabbits and one dog with lochial solution by itself, or mixed with antiseptics.

Infected seven rabbits with purulent fluid diluted, or mixed with antiseptics.

Of these in nine instances (rabbits), and in one (dog), recovery took place.

In ten experiments the animals (rabbits) were inoculated by injection through the vaginal wall.

In six experiments the animals (rabbits) were inoculated by injection *per perinæum*.

In four experiments the animals (rabbits) were inoculated subcutaneously.

In one experiment the animal (dog) was inoculated by injection *supra pubem* into the abdominal peritoneal cavity.

SERIES C: Injected five rabbits with freshly removed peritoneal purulent fluid from a patient.

Injected two rabbits with freshly removed sanguineous peritoneal fluid from a patient.

Of these in the two last instances (rabbits) recovery took place.

In three experiments the animals (rabbits) were inoculated by injection through the vaginal wall.

In one experiment the animal (rabbit) was inoculated by injection *per perinæum*.

In three experiments the animals (rabbits) were inoculated subcutaneously.

The conclusions drawn by the authors from their experiments are summarized as follows:—

"We may then infer from our three series, consisting of fifty-four experiments: (1) that the fact of the septic fluid having been derived from a serous cavity, as the peritoneal, is not the cause of the septicity; (2) that the purulent condition (*de novo* or by admixture) intensifies its septic power; (3) but that pus alone is not necessarily septic to animals, as has been previously repeatedly proven by various experiments; (4) that purulent fluid from a serous cavity (especially that from the abdominal peritoneal cavity) is more lethal than that derived from connective tissue; (5) that putrefaction or decomposition decidedly intensifies the septic or lethal action of a septic fluid; and that (6) the septic influence of human lochia on rabbits is due to some special property in it (*sui generis*), and is not connected with the presence in it of micrococcus organisms."

If we contrast with these results those obtained by myself from the subcutaneous injection, in the rabbit, of human saliva, we shall find very striking differences, which may be summarized as follows: (1) greater mortality; (2) lethal dose much smaller; (3) date of death and pathological appearances quite uniform; (4) putrefaction of saliva destroys its virulence; (5) virulence is connected with the presence of micrococci; (6) serum from subcutaneous connective tissue and blood from an animal recently dead swarms with micrococci, and is virulent in the smallest quantities; (7) antiseptics promptly destroy virulence of saliva and of fluids from the body of infected animals.

I shall now proceed to discuss in detail, but as briefly as is consistent with the object in view, each of the above-enumerated points of contrast.

(1) *Greater Mortality.* The tabular statement of experiments made by Braidwood and Vacher shows that rabbits were inoculated with septic fluids, through various channels, 51 times, with a fatal result in 33 instances. In ten experiments antiseptic substances were mixed with the septic fluid used, with a fatal result in eight instances. In several cases the fatal result seems to have been due to an accidental complication. Thus, the notes of the experimenters show that in experiment No. IV., in which death occurred thirty hours after injecting one drachm of lochial fluid, *per vaginam*, into the pelvic cavity of a rabbit, the necropsy showed "a large clot in the right iliac region external to the muscles." In experiment V., in which the injection was made into the abdominal perito-

neal cavity, death occurred in eighteen hours, and the post-mortem examination showed that the intestine had been punctured by the hypodermic needle. In experiment VIII., it is recorded that the animal received accidentally a bruise over the right hip, which gradually induced a subcutaneous abscess. In experiment XXV. the remark is made: "Death probably resulted from an accident, as shown by the necropsy." Excluding these experiments we have left 37 with a mortality of 21. How far this mortality was dependent upon the fluid injected *as a septic fluid*, and how far it was due to injury inflicted by the hypodermic needle at the time of the operation, or to the mere presence of the fluid introduced into the pelvic or peritoneal cavities, it is impossible to determine, but it is evident that there is a greater liability to accidental complications in this method than in the method by subcutaneous injection into the connective tissue, employed by myself. The contrast as to mortality, however, is very striking. I say in my original report:—

> "I have demonstrated by repeated experiments that my saliva in doses of 1.25 c. c. to 1.75 c. c., injected into the subcutaneous connective tissue of a rabbit, *infallibly produces death*, usually within forty-eight hours."

The number of experiments upon which this announcement rests I am not able to give at the present moment, as my detailed report of these experiments is in the hands of the National Board of Health, and I have not a retained copy at hand.[1] I think, however, that I am quite safe in saying that I have repeated the experiment at least twenty-five times with my own saliva. But experiments made subsequently to the writing of the above quotation from my original report, make it necessary for me to slightly qualify the language of this. I can no longer say *infallibly* produces death, as in several instances death has not occurred in rabbits which had been previously injected with saliva mixed with certain substances—alcohol, quinine—which, when added to it in a certain proportion, prevent the usual fatal result, but do not prevent an impression being made by the mixed injection, which seems subsequently to protect the animal from the lethal effects of injections of saliva alone.

I have not yet performed a sufficient number of experiments to enable me to speak with confidence as regards the protective influence of these mixed injections, but hope to pursue the investigation at some future time.

(2) In the experiments of Braidwood and Vacher the amount of septic fluid injected was from half a drachm to a drachm and a half. There is good reason to believe that this amount of pus, or of "grumous lochial fluid" introduced into the pelvic or peritoneal cavity of a rabbit might give rise to secondary deposits in the liver, etc., and produce death from causes quite independent of the septicity of the fluid injected. This view

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[1] This detailed report, I am informed, will be published in full in the Annual Report of the National Board of Health for the year 1881.

is sustained by the remote period at which death occurred in a number of cases, and by the post-mortem notes, which show that secondary deposits in the liver, etc., were of common occurrence in these cases.

In my experiments the maximum amount of saliva injected was less than the minimum quantity of septic fluid used by Braidwood and Vacher, and there is good reason to believe that still smaller quantities would have been quite as effective, as *the smallest dose produced death quite as promptly as the largest.* In one experiment with small rabbits three out of five succumbed to an injection of one minim of saliva diluted with five minims of distilled water (each).

I beg those who undertake to repeat my experiments to observe that *my* saliva in the quantities mentioned produced the results recorded. The question as to whether the saliva of other individuals injected in the same manner would produce similar results is answered as follows :—

> "The saliva of four students, residents of Baltimore, gave negative results; eleven rabbits injected with the saliva of six individuals in Philadelphia gave eight deaths and three negative results ; but in the fatal cases a less degree of virulence was shown in six cases by a more prolonged period between the date of injection and the date of death."

Vulpian has since reported to the French Academy results corresponding with my own, so that it is evident that I do not alone enjoy the distinction of cultivating in the secretions of my mouth a micrococcus fatal to rabbits when introduced beneath their skin.

(3) In the experiments of Braidwood and Vacher death occurred at a later date than seven days in no less than 13 out of 21 fatal cases under consideration, and the pathological appearances noted are not at all uniform in character. In my experiments the rabbits were so commonly found dead or dying on the second morning after inoculation that I have come to look upon thirty-six to forty-eight hours as the duration of the fatal infectious disease produced thereby. The constant and characteristic pathological lesion found by me was a diffuse cellulitis, or inflammatory œdema, extending in all directions from the point of injection, attended with an abundant exudation of bloody serum swarming with micrococci.

Hemorrhagic extravasations in the subcutaneous connective tissue and in various organs were of frequent occurrence, and changes in the liver and spleen, such as are common to quickly fatal septic diseases, were commonly found. The spleen was usually greatly enlarged, and sometimes contained black pigment; the liver was frequently dark in colour, and gorged with blood, but more often of a leather colour, and containing much fat, resembling, in these particulars, the liver of yellow fever.

(4) Braidwood and Vacher find "that putrefaction or decomposition decidedly intensifies the septic or lethal action of a septic fluid." In my experiments putrefaction was found to destroy the virulence of the saliva. When this fluid was kept in a *culture* oven for twenty-four hours, at a

temperature of 37° cent., it developed an odour of putrefaction, and *no longer* produced any noticeable results when injected beneath the skin of a rabbit.[1]

(5) In my experiments, micrococci in great abundance were constantly found in the bloody serum from the œdematous connective tissue, and usually in the blood of rabbits just dead. By filtration and culture experiments proof was furnished that the virulence of these fluids depended upon the presence of the micrococci. Braidwood and Vacher find that "the septic influence of human lochia on rabbits is due to some special property in it (*sui generis*), and is not connected with the presence in it of micrococcus organisms." The latter clause of this proposition may be accepted upon the evidence furnished by the experimenters. But it may be questioned whether the septic influence of human lochia "is due to some special property in it *sui generis*." In the tabular statement of their experiments the authors make such remarks as the following, in referring to the lochial fluid injected into rabbits: "Had a slightly fetid odour;" "fluid very fetid, sanious and grumous;" "filled the sloughing wound with two pellets of cotton-wool which had been soaked, 70 *hours previously*, in fetid lochia from Mrs. G.," etc.

(6) Although the experimenters failed in certain cases to note the presence of the bacteria of putrefaction in the lochial fluid injected into their rabbits, as, for example, in the instance in which this is described as "very fetid, sanious, and grumous," there can be very little doubt that putrefactive changes had taken place, and there seems to be no good reason for assuming the presence of some "special property" differing from that found in other putrefying material of animal origin. According to my observations, the vaginal mucus of healthy females contains an abundance of bacterial organisms, and it is quite probable that, under the favouring influence of an elevated temperature, the lochia is usually more or less advanced in putrefaction before it reaches the vaginal orifice, especially when the flow is scanty, and a well-closed os tends to the retention of the fluid within the uterus. The lochial fluid as it escapes from the uterine vessels is probably bland and harmless, not differing materially from blood-serum, and holding in suspension a certain number of the corpuscular elements of the blood. In the serum present in the œdematous connective tissue of a rabbit killed by the injection of saliva, we have a fluid similar in its origin—from the blood—and in its physical characters so far as the naked eye can discern. But the microscope reveals in it the presence of innumerable micrococci, and experiment shows that a minute quantity introduced beneath the skin of a healthy rabbit will produce speedy death. I have in a number of instances, and as often as the experiment was tried,

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[1] My saliva is odourless, and has the normal reaction. I am not aware that it presents any peculiarity unless it be that it is secreted in unusual abundance. My teeth are sound, and I do not use tobacco.

produced fatal septicæmia in a rabbit by introducing beneath its skin a hypodermic needle dipped in the blood of a rabbit just dead as the result of an injection of saliva.

(7) Finally, in the experiments of Braidwood and Vacher, in which antiseptics were mixed with the septic fluids injected into rabbits, the mortality was increased by this admixture, showing that these so-called antiseptics—carbolic acid, sulphurous acid, potassium permanganate—did not neutralize the poisonous septic element in the fluids used.

On the other hand, a series of experiments made by myself to test the comparative value of disinfectants[1] has demonstrated conclusively the power of these and many other substances generally recognized as antiseptics, to destroy the virulence of blood and serum from a septicæmic rabbit killed by an injection of human saliva. The proportion required differed with different substances and was considerably greater for carbolic acid and potassium permanganate than for iodine, ferric sulphate, and the mineral acids, being less than 0.5 per cent. for the latter, while 1.25 per cent. of carbolic acid, and 2 per cent. of potassium permanganate was required to disinfect the virulent fluid used in my experiments. The proportion of these disinfectants used by Braidwood and Vacher was considerably in excess of this (5 per cent. of carbolic acid and a saturated solution of potassium permanganate), indeed, the quantity injected was so great that it is difficult to decide whether the septic fluid or the antiseptic agent mixed with it was responsible for the death of the animals experimented upon.

In my experiments with disinfectants the result was very striking. In 46 instances the subcutaneous injection of virulent blood and serum from septicæmic rabbits, mingled with various antiseptic substances, gave negative results, whereas the virulence of the same fluids was demonstrated by comparative experiments in which a much smaller quantity was used, and by 35 experiments in which inefficient quantities of efficient antiseptic agents or solutions of substances which proved to be inert, were mingled with the virus. Thus carbolic acid failed at 0.5 per cent., but was efficient at 1.25 per cent.; potassium permanganate failed at 1 per cent., but was efficient at 2 per cent.; potassium nitrate and sodium chloride failed at 4 per cent., etc. etc.

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[1] Board of Health Bulletin, July 23, 1881.